Minuteman Repeater Association

The Minuteman

Volume 55 Number 3 January 2026
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The Minuteman Repeater Association is a non-profit organization providing communications infrastructure and volunteers for community and emergency events.

Membership Meeting: Wednesday, 21 January 2026 ~7:30 - 9:30 pm

Introduction to WSPR and Other Digital Modes

Charles Bures - WA3ITR

This is a Hybrid meeting: New England Sci-Tech + ZOOM

(Directions to New England Sci-Tech- on Page 3)

Members: log into your account on MMRA.ORG to obtain the ZOOM info.

Charlie will discuss the origin of WSPR and the new digital modes invented by Joe Taylor and his colleagues. The presentation will begin with the historical context of their creation, emphasizing their role in enabling long-distance communication with minimal power.

Key highlights included:

- **WSPR's role in propagation analysis.**
- **Brief coverage of the Maidenhead grid system, used for location reporting in digital QSOs.**
- **A step-by-step walkthrough of a digital QSO, illustrating how messages are exchanged and decoded.**
- **Limited deep-dive into the magic that makes all this possible.**

Charlie will share his personal experiences operating these modes and highlighted their value for amateur operators.

Charlie got into amateur radio in high-school in the early 1960's. His Novice call was WN3ITR and when he obtained his General, it became WA3ITR, which he has kept ever since. Charlie graduated from MIT in course 6 (Elec. Eng.), but his primary love was software. After a graduate degree from Stanford, he focused on software for his entire career. He has worked in many application areas as a consultant and always kept his interest in radio. About thirteen years ago, he successfully passed the Extra exam. He has been involved in the Wellesley Amateur Radio Society (WARS) for 25 years and is currently in his second year as President.

Join us for the next [ZOOM] MMRA Ham Radio Chats on January 14th and February 11th

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President's Corner ~ David Hornbaker, N1DCH

Happy New Year!

The Milton antennas have finally arrived! We are just waiting on the tower climber. If the weather cooperates, we should have the Milton repeaters operational shortly.

MMRA has its first public AllstarLink node. Node 671072 is live on Hub2 in Weston. The node supports multiple AllstarLink and Echolink connections. The plan is to install a node at Hub1 after we gain some experience with Hub2.

I look forward to seeing you at the Algonquin Flea Market, February14th, 2026. MMRA will have a table and the MMRA VE Team will be conducting an Amateur Radio Exam Session.

All MMRA memberships expire on August 31 of the membership year. Please check your profile and if your membership expired in 2025, please renew. Renewals may be done on the website, or you can mail your renewal to: Minuteman Repeater Association, PO Box 2192, Littleton, MA 01460-3192. Please allow 7 days for us to process your renewal. Please allow 14 days for renewals that are mailed. While you're on the website (https://www.mmra.org) checking your expiration date **please verify your email address.**

Join us for the January 21st, 2026, membership meeting at New England Sci-Tech in Natick. If you cannot make it to Natick, this will be a hybrid meeting, and the Zoom meeting information is available on the website (www.mmra.org). You must be logged into the website to view the information.

The MMRA Ham Radio Chat is a Zoom meeting, which is held on the second Wednesday of the month, and is open to all. You do not have to be a member or licensed to attend. See the article later in this newsletter for more information.

Join us Tuesday nights at 8:00 PM for our weekly Technical Information and Other Stuff (TIaOS) Net, on the linked repeaters of the MMRA. There will be a lively discussion on all sorts of HAM issues, including equipment, antennas, software, repeaters, and other stuff. The main purpose is to test our ability to link up the repeaters in case of an emergency, or to support some event like a marathon. You can also join via EchoLink. See below for more information.

You can find out more information about how and when the repeaters are linked on the website < https://www.mmra.org/repeaters/repeater_linking.html >.

Please remember to keep your profile up to date, especially if your email changes. Note that if your callsign changes, send email to contact@mmra.org and we will update your callsign in the database.

Upcoming MMRA Amateur Radio License Exam sessions:

January 24th, 2026, 9:00 AM Marlborough Central Fire Station, 215 Maple St (RT 85), Marlborough, MA, Pre-register here:https://ham.study/sessions/695191b3887662138cb7cb3f/1

February 14th, 2026, 9:00AM 1 Lt Charles W. Whitcomb School, 25 Union St Marlborough, MA

Pre-registration: https://hamstudy.org/sessions/695ef544e2fd59c806d3e1c1/1 . Walk-ins are accepted. Please have your FRN and federal or state photo id when you check-in to the session.

Net Control Operators wanted! Interested in becoming a control operator for the TIaOS net? Larry is looking for a back-up operator. Contact Larry Banks – W1DYJ w1dyj@mmra.org.

Do you know someone that has passed the Technician test (element 2) in the last 365 days? They are eligible for free membership in MMRA. Have them send email to contact@mmra.org requesting membership. The club secretary will contact them with details on how to qualify.

73 — Dave – N1DCH

January Treasurer's Report ~ Kevin Paetzold, K1KWP

The MMRA receives donations each year. On behalf of the club I would like to acknowledge and thank the following members (and an organization) who have donated since my list in the November newsletter: **KC1APU, KC1DKW, KB1WMC, K1VK, VK6ANU, BARS, KC1NYR.** Hopefully I did not miss anyone on this list. BARS is the Billerica Amateur Radio Society and their donation to the MMRA is appreciated.

MMRA policy does not allow other clubs (as a club) to join as members. However support from hams in the Billerica area is greatly appreciated. Now that this uphill/tough row has finally been hoe'ed the actual out of pocket cost for moving the Billerica repeater is listed below.

The relocation of the former Quincy repeaters to Milton is moving along. The antennas have both been shipped (the 220 antenna was delayed a couple weeks). At this point this is just waiting on the climbers schedule, and mother nature.

Billerica Repeater relocation project cost		**Quincy to Milton Repeater relocation project cost**	
220 antenna	$1140	2M and 220 antennas	$3200
Tower and Coax Work	$5360	Tower and Coax Work	$4500
Locksmith	$230		
Total	**$6730**	**Total**	**$7700**

I count paid memberships (I am the treasurer ☺.) So far **309** members have either renewed or recently joined for this membership year. That is an 18% increase over the previous membership year ☺. At this instant there are 345 active/voting members (the difference is due to free memberships for new hams).

I would like thank David, KC1VZH for volunteering to evaluate/cleanup/market items which have been donated to the MMRA. This has already resulted in $203 in income ☺.

On June 1, 2025 we had $19147. At this writing we have $15155. The tower climber/coax work for Milton has not yet been paid for. On June 1, 2026 I predict we will have $10265 +/- any additional income or spending that I do not already know about at this date.

73, **K1KWP**

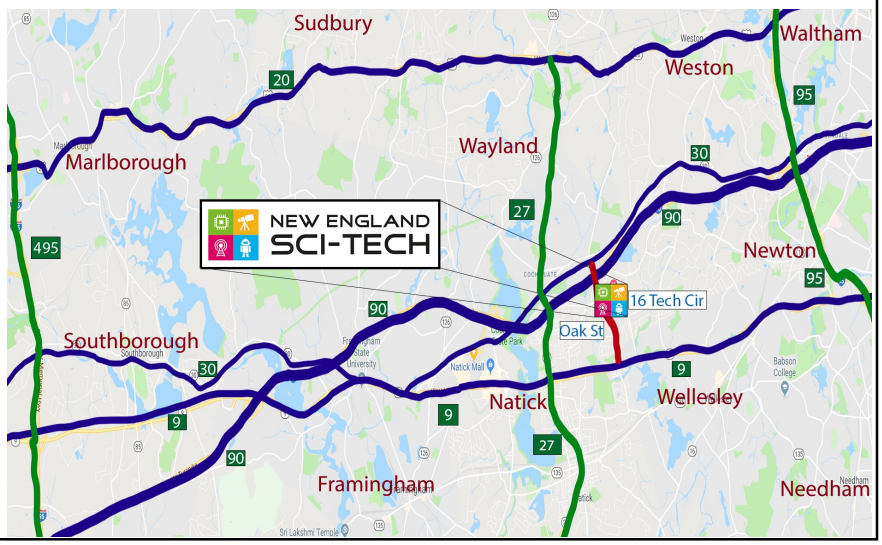
Directions to New England Sci-Tech Inc.

16 Tech Circle **Directions** Natick MA 01760

From the north: take Rt 95 or Rt 27 or Rt 495 south to Route 30 toward Wayland. Once in Wayland, turn South on Oak Street and in 1/2 mile look for Tech Circle on your left. Follow Tech Circle to the end.

From the south: take Rt 95 or Rt 27 or Rt 495 north to Route 9 toward Natick. At the Wellesley-Natick line, turn North on Oak Street and in 1/2 mile look for Tech Circle on your right. Follow Tech Circle to the end.

From the east or west: follow either Rt



The Case of the RF Ghost: A Lesson in Passive Intermodulation (PIM)

Bob DeMattia, K1IW

Ever heard a signal on a frequency where it shouldn't be? An operator located roughly 5 miles from the Billerica repeater site recently reached out regarding persistent interference on the **146.520 MHz National Calling Frequency**. The signal was just strong enough to break squelch (-97 dBm), making the frequency unusable at their station.

After a deep-dive investigation using a spectrum analyzer and some high-school math, we solved the mystery. It wasn't a "rogue" transmitter—it was a ghost created by physics.

The Suspects: We identified two strong signals hitting the receiver:

F1 (Prudential Center): 146.820 MHz (Boston)
F2 (Billerica Site): 147.120 MHz

The Math: Using the formula for 3rd Order Intermodulation Distortion (IMD3), we plugged in the frequencies of the two strongest signals in the area. The formula **(2 x F1) - F2** is a classic culprit for creating "phantom" signals.

(2 x 146.820) - 147.120 = 146.520 MHz

The math was an exact match. The "interference" on 146.520 was actually a 3rd-order product created by these two signals colliding. But where were they colliding?

Proving the Innocence of the Prudential (146.820)

First, we checked if the interference was being generated at the Boston site. For the Billerica signal to "mix" with the Boston transmitter at its source, it would have to travel 15 miles site-to-site. Even then, we have to look at the **Return Path**.

The free-space path loss from the Prudential back to the operator's station is approximately 102 dB. To result in a -97 dBm signal at the receiver, that tower would have to be radiating the specific interference at a power level of +5 dBm (about 3.1 milliwatts). This math was confirmed by a control station located 3 miles south of the affected operator; despite being 150 feet higher in elevation and significantly closer to the Boston source, this control station heard absolutely nothing on 146.520 MHz. Boston was mathematically and geographically acquitted.

Proving the Innocence of Billerica (147.120)

Next, we looked at the Billerica transmitter. For our operator located 5 miles away, the path loss is approximately 94 dB. For this repeater to be the source of a -97 dBm signal at that 5-mile mark, it would have to be radiating the "mix" at a level of -3 dBm (approximately 0.5 milliwatts).

To verify this, we conducted a field test in the immediate near-field of the Billerica transmitter (within 100 feet of the antenna). If the Billerica antenna were actually radiating 0.5 mW on 146.520 MHz, our near-field scan would have detected a signal at roughly -25 dBm. Instead, our scans showed absolute silence. This definitively proves the interference wasn't being transmitted from the site; it was being manufactured at the destination.

The Mathematical Alibi: Excluding 146.715 MHz

In any good investigation, you have to rule out all nearby high-power sources. We looked at a third regional transmitter operating on 146.715 MHz. A "Two-Tone" analysis proved it was physically impossible for this station to contribute to the interference on 146.520 MHz. In the world of RF interference, math is the ultimate alibi.

The Receiver Variable: Is it the Radio?

Before concluding the issue was external, the possibility of **Receiver IMD** had to be considered. A radio's front-end circuitry can sometimes be overloaded by strong local signals, causing it to "manufacture" a ghost frequency internally. In this investigation, the reporter observed the signal on two very different pieces of hardware: a standard transceiver and a spectrum analyzer. Because these two distinct devices with different internal architectures both detected the interference, the focus shifted away from an internal equipment fault and toward a physical "mix" occurring in the local environment.

While we didn't have the data from an attenuation test in this specific case, a classic diagnostic is the **3dB/6dB Rule**: adding a 3 dB attenuator to the line should result in exactly a 3 dB drop if the signal is external. If the signal drops by 6 dB or more, it's a sign the receiver itself is creating the distortion. Here, the consistency across multiple

The Case of the RF Ghost: A Lesson in Passive Intermodulation (PIM)

Continued—Bob DeMattia, K1IW

devices was the key evidence that the signal was indeed present at the antenna.

The Verdict

With the transmitters cleared, the only place left for the signals to mix was at the receiving station itself. To confirm this, we performed a mobile receiving test at street level directly in front of the subject property, roughly 100 feet from the station's antenna. No signal was detected.

How can an operator hear a signal at -97 dBm while a test rig 100 feet away hears nothing? The answer lies in the **efficiency of the "mixer."** If a corroded connector is acting as a non-linear junction, the phantom signal it creates is incredibly weak. While it has enough power to travel a few feet down a shielded feedline directly into a sensitive receiver, it lacks the power to radiate effectively into "free space."

Its absence at street level confirmed that the interference was "conducted" within the operator's own system (**the antenna itself, the tower, a mounting clamp—any kind of corroded metal**). This is known as **Passive Intermodulation (PIM)**.

The Solution

The recommendation? A **"Shake Test"**— monitoring the signal while physically manipulating cables and connectors to find the exact corroded joint or loose bolt acting as the mixer.

Takeaway for the Club

Do the math: See if local repeaters land on your frequency using standard IMD formulas.
Check your hardware: PIM is almost always caused by "the little things"—oxidation, loose connectors, or old coax.
Trust the physics: If the math and field tests don't support a long-distance path, the problem is likely at your own station!

Sidebar: The IMD3 "Quick-Check" Table

Intermodulation Distortion (IMD) doesn't just happen on 146.520 MHz. If you have two strong local signals, your station hardware could be "manufacturing" phantom signals on several other common frequencies.

Common Mixing Scenarios (2A - B = C)

Signal A (F1)	Signal B (F2)	Resulting "Ghost" (F3)
146.820 (Boston)	**147.120** (Billerica)	**146.520** (Calling Freq)
146.640	**146.940**	**146.340** (Input Freq)
147.000	**147.300**	**146.700**
146.715	**146.820**	**146.610**

The "Rule of Threes" for Troubleshooting

If you suspect you are hearing a ghost signal, ask yourself these three questions:

Is it "Math-able"? Use the formula (2F1 - F2). If the result matches what you're hearing, you have an IMD problem.
Is it broad or local? Ask a friend a few miles away to listen. If they don't hear it, the "transmitter" is likely a rusty bolt or connector on your own tower.
Does the "Shake Test" change it? Use a plastic tool or a gloved hand to wiggle connectors or tap mounting brackets. If the noise floor jumps or the signal drops, you've found your non-linear junction!

Boston 900 Back in Service ~ Roger Coulson, WA1NVC

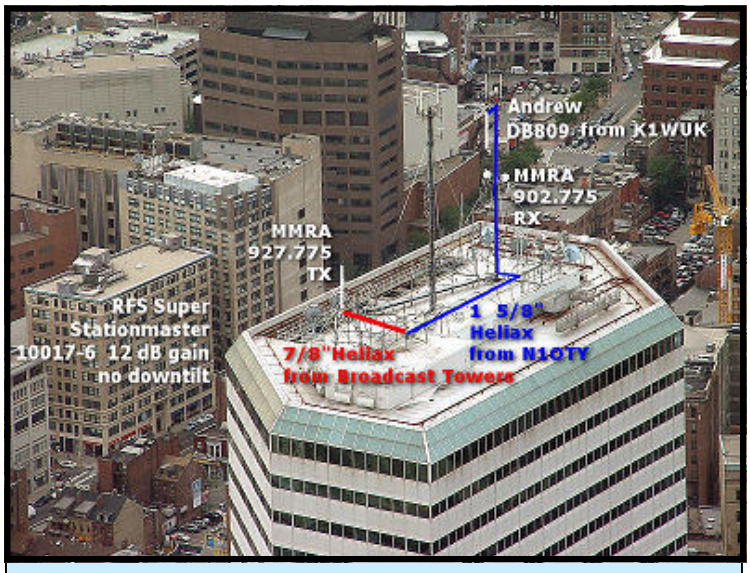
The new BOS 900 MHz Repeater is now in place at OFC and working. All the network connections, and both analog and P25 are working. I want to thank John Mullaney, Luke Willis, and Peter Kovaleski for making this all happen.

Some photos from the reinstallation:

The repeater in John's car on the way to Boston

The repeater

Ready to go! A really clean "shack."



The Antennas on top of One Financial Center

19 November 2025 Membership Meeting ~ Minutes I

Called to order @ 7:36PM© 2025, MMRA

Repeater Status Report: - Bob DeMattia – K1IW

Billerica 147.12 – is back on the Air as of this past Wednesday. Link Radio is up. Both Repeaters are linkable.
Milton 146.67 & 224.400 – The site is progressing. Bob is working on arranging the tower climber to install the antennas when we receive shipment.
Marlborough 900 – temporarily off the air while the node is rebuilt. ASL is running and is connecting to 900 MHz network.
Boston 900 – is built, ready for deployment.
Echo/IRLP 4136 (Hub2 442.700) and IRLP 4978 (Marlborough 900) have been rebuilt and is ready for deployment.
Echo/IRLP 4133 (Hub1 449.925) when HUB2 is complete, HUB1 will be removed for a rebuild. HUB2 will take its place.
ASL Nodes for HUB1 & HUB2 are ready to be deployed.
Burlington - 145.43 (ex-Belmont) – pending install of additional cavity to fix de-sense issue.
Weston – 146.79 – Antenna SWR is still high. No activity scheduled to address this yet. The repeater is intermittent.
All other Repeaters: Functioning normally.

Ham Radio Chat/Elmer) Forum – Kevin – K1KWP

Since last month's meeting, a name change to this teaching/learning forum has been chosen to "Ham Chat". These Meeting are still on the 2nd Wednesday of each month and are designed primarily to help new Hams get on the air as well as continue to be informal, relaxed sessions focused on mutual learning. During this past session one of the subjects discussed was AI in terms of how each of us are using it or not using AI. This was a lively discussion, and we suggest you participate in the next upcoming discussion whatever topic that may be. Please go to our website for the Zoom details. Next session is on Wednesday, December 10th at 7:30 PM.

Exam Session – November 2025

Saturday, November 22, 2025, at 9:15 AM
Marlborough Public Library Meeting Room 1, 18 Witherbee St, Marlborough MA 01752.
Online Registration is the preferred option. HamStudy.org: Exam details
Walk-Ins are welcome
Please tell your friends, who are interested in taking tests, that they must have photo IDs and FRNs (and please **obtain your FRN# f**rom the FCC Website **prior to arrival**).
Copy of license required if upgrading (or proof from the ARRL or QRZ)
Note: SS#s, are no longer accepted by the FCC. *Everyone must have an FRN.*

Exam Session – December 2025

Saturday, December 20, 2025, at 9:15 AM See above for additional details
Marlborough Public Library David Meeting Room, 18 Witherbee St, Marlborough MA 01752.

19 November 2025 Membership Meeting ~ Minutes II

Upcoming Meetings

December 17, 2025, 7:30 PM	Business Meeting	Zoom
January 21, 2026, 7:30 PM	Membership Meeting	NE Sci-Tech and Zoom
	Introduction to IT-65 & WSPR	*Charles Bures, WA3ITR*
February 18, 2026, 7:30 PM	Business Meeting	Zoom
March 18, 2026, 7:30 PM	Membership Meeting	NE Sci-Tech and Zoom
	How to Precisely Calibrate Your Transceiver	*George Allison, K1IG*
April 15, 2026, 7:30 PM	Business Meeting	Zoom
May 20, 2026, 7:30 PM	Annual Meeting & Elections	NE Sci-Tech and Zoom
	A Technician's Journey: From HT to HF	*David Kula, KC1VZH*

Tuesday night at 8:00 PM (year-round) Technical, information and Other Stuff Net: MMRA Repeaters

Meeting informally ended at 8:02 PM

Presentation: Antenna Modeling Part 1 EZNEC – Larry Banks – W1DYJ

Larry was licensed in 1961, as Novice KN1VFX, and later became W1DYJ in 1966. Larry currently holds an Amateur Extra class License. He was an engineer and project/section manager at Hewlett-Packard Medical's Cardiac lab in Waltham and Andover MA starting in 1969. He holds three degrees in EE from MIT. He spends his time chasing DX and contesting in Woburn, traveling with his wife Maren, and attending – streaming – many jazz and classical concerts. Larry is the Net Manager and Newsletter Editor for the MMRA, publications editor for HamXposition and a member of the YCCC

To start, Larry quoted British Statistician *George Box*: "All Models are wrong. Some are useful." Next, he stated that the acronym NEC means the Numerical Electromagnetic Code and EZNEC as the software he uses for antenna modeling. EZNEC is free. EZNEC uses either NEC version 2, which is free, and/or NEC version 5, which costs $110 and Larry suggests that for most of us the free version is more than adequate for comprehensive antenna modeling. As an Engineer who spends time building and modeling antennas, Larry had to purchase V5, but stated to us there is very little difference between V2 and V5.

Larry demonstrated the power of NEC-V2 as he started with a 40-meter band simple center fed dipole antenna in "free space". Based on the SWR minimum from EZNET, Larry tweaked the dipole length to meet his design frequency. Larry then showed the effect of soil parameters used. Larry mentioned that QST articles use average soil in their measurements rather than the poorer soil we have here in New England, a precaution to the results we will obtain. As an aside, salt water is an excellent conductor, distilled water is not a conductor at all, and lakes and streams vary in conductivity depending on their mineral content.

Larry added more variables to this presentation. Next, he compares a vertical antenna versus a dipole. Both have their strengths and weak points depending on what you are trying to accomplish: local contacts or DX contacts. In summary, there is no perfect model or antenna which makes Ham Radio a forever challenge. Larry firmly states, "you can't beat physics". Larry's presentations can be found on Larry's web site: https://www.qsl.net/w1dyj/. This talk is at: https://www.qsl.net/w1dyj/#ANT and the meeting video is at: https://drive.google.com/file/d/1DWyOnVce2u2MIcMyosYCtC36B42ZAGdN/view?usp=sharing

19 November 2025 Membership Meeting ~ Minutes III

Meeting Attendees at Marlborough Central Fire Station, Marlborough MA
David Hornbaker, N1DCH; Ken Horton, KA1GFN; Deb Horton, N1NVJ; Larry Banks, W1DYJ; Stephen Babbitt, KC1LPZ; Glenn Ghidaleson, WA2KRS; Ron Rothman, WO1E; Jim Sullivan, KC1WMW; Eric Williams, KV1J; Bill McIninch, KA1MOM; Bob De Mattia, K1IW; Kenny Peluso, KC1PFS; Tom Sullivan, KC1VHD; Bruce De Graaf, KC1IUS; Alexander Marrero, KC1YGJ;

Zoom Meeting Attendees:
Kevin Paetzold, K1KWP; Joe Fratto, K1UN; David Kula, KC1VZH; Lizzie DeMarco, KC1SUY; Roger Coulson, WA1NVC; Chris Lamberson, AA1NG; John Nitzke, KF1KI; Brent Macaloney, WM1T; Erving Chamberlin, N1ECC; Bill Hannahan, W1WH; Horace Dufresne, KC1TJX; Brendan Welch, W1LPG; Larry Vidoli, W1LSV; Brent DeWitt, AB1LF; Jim Babb, AA1BA; Rich Zach, KK1RZ; John Mills, K1JSM; Alan Lewis, K1ALL; Lee Gutkopf, KC1YIL;

Meeting Adjourned at 9:15 PM

Respectfully Submitted by Stephen M Babbitt, KC1LPZ, Clerk

HAM RADIO Algonquin Amateur Radio Club HAM RADIO
Marlborough, MA

AMATEUR RADIO **FLEA MARKET**

Saturday, February 14, 2026

$200 Cash Door Prize! To be awarded at 11:30 Must be present to win

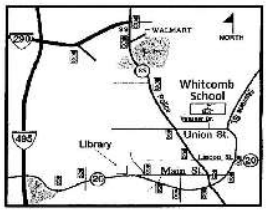
Marlborough 1Lt Charles W. Whitcomb School
(formerly Intermediate/Middle School)
25 Union St. or
off Bolton St. (Rt. 85)
Marlborough, Massachusetts

6 ft. Tables (round and rectangular)
Tables are $25.00 each if purchased by February 6, 2026 ($30.00 each accepted at the door if tables or spaces are available, no guarantees)
Tables include vendor admission for one person.

SETUP TIME: 6:30 AM
For more information email:
fleamarket@n1em.org

Talk In: N1EM/R 446.675 - (pl 88.5)
Updates will be on our web at:
http://n1em.org

Time: 9:00 AM to 12:00 Noon
General Admission: $5.00
VEC Exams: 9:00 AM



Send This Form For Table Reservations with Check Payable to:
AARC, PO Box 258, Marlborough, MA 01752 ($25.00 each table due by February 6)
Name:_____Call:_____
Address:_____No. Tables:_____
City:_____State:_____Zip:_____
Telephone:_(____)_____Amount Enclosed: $_____.00
Email:_____

The MMRA Ham Radio Chat

The Minuteman Repeater Association (mmra.org) hosts a monthly ham radio discussion on ZOOM for **anything Ham Radio related**.

Ask questions. Share discoveries. Speak with other local hams. Find out how to get a License and on the air. Buying equipment. Programming your radio. Info about local ham resources. Find mentors and elmers.

Everyone is invited whether licensed or not. No need to be a member of the MMRA.

When: Second Wednesday of each Month at 7:30PM

upcoming 2026 dates: Jan 14, Feb 11, Mar 11, Apr 8, May 13, Jun 10
Jul 8, Aug 12, Sep 9, Oct 14, Nov 11, Dec 9

Where: ZOOM Meeting ID: 876 8326 0138 Passcode: elmer
full zoom invite info at
mmra.org/chat/

Ham radio "mentors" have been traditionally known as "Elmers." Elmers are the unsung heroes of ham radio, passing on their knowledge and enthusiasm to the next generation of operators helping them learn the technical aspects of radio operation, regulations, and navigating the social aspects of the ham radio community.

Whether you have been licensed for weeks or for years you may be able to help answer questions from others. Share your knowledge and experience with other hams EVEN if you are just recently licensed.

revised: 20260107

19 November 2025 Membership Meeting ~ Minutes IV

Antenna Modeling Part 1 EZNEC – Larry Banks – W1DYJ

Antenna Modeling

Part I: EZNEC

[Part II: TLW, YW, HFTA]

Larry Banks, W1DYJ

Much cheaper (and faster) than (re)building them!

"All models are wrong. Some are useful"

British Statistician George Box, 1976

Antenna Modeling: EZNEC ~ Agenda

- Why I became interested in antennas: *An Antenna Story*
- NEC *Numerical Electromagnetics Code*
  - Modeling Software using NEC
- EZNEC
  - EZNEC Intro
  - Inputs & Outputs (Simple 40M dipole)
  - Ground Characteristics
  - Example

The Goal: You will learn some theory and gain some understanding about antennas.

An antenna story ~ the Gotham V80

- New novice KN1VFX - 1961
- *I knew nothing about antennas*
- I built a HB 80m 807 CW [XTL] transmitter
- I fed my end-fed random wire out of my 2nd floor bedroom window [SWL]
- It didn't work

A 1962 QST Advertisement

- My first "real" antenna for 80M
- $16.95 was "big bucks" for a junior in HS in 1962 ($180 today)

A beautiful example of *MARKETING!*

An antenna story ~ the Gotham V80

Radials not required

- I never worked anyone – Best DX was a 40M OO report: "Out of Band"
- As a result, I never really learned CW
- I have not believed advertisements since!
- I also learned that *you need to understand the physics* of antennas

→→→ Modeling

NEC: Numerical Electromagnetics Code

Uses a ***Method of Moments*** algorithm *(fields from many mutually-coupled straight-line segments are evaluated and vector-summed)*

- NEC-2 (1980) – available to the public and free
- NEC-4 (1992) v4.2 (2011)
  - Requires license: $110 from Lawrence Livermore Labs
  - Fixes stepped wires; wire junction; ground issues, etc.
- NEC-5 (2020) [ver x13] (2022)
  - Requires license: $110 from Lawrence Livermore Labs
  - Allows buried conductors and other improvements

Modeling Software using NEC

EZNEC — W7EL, Roy Lewallen

AutoEZ (AC6LA) $79 (automates EZNEC)

NEC-Win Plus/Pro >> now legacy software

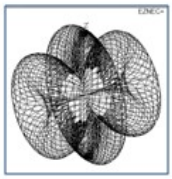
MMANA-GAL (free)

4nec2 (free)

MiniNEC $29

EZNEC - Intro

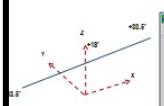
Basic Purpose: from an X-Y-Z "wires" description of an antenna, generate tabular and graphical outputs of SWR, far field response, RF antenna currents, etc.



Modeling Software >> NEC- 5 vs -2 *[from Google]*

- **NEC-5** is a proprietary, paid software engine that offers significant improvements in accuracy and capabilities compared to the older, free NEC-2, particularly in handling complex modeling scenarios like **buried conductors, surface patches, certain close-spaced elements, and intensive segmentation requirements.**
- **NEC-5 v. NEC-2**
  - Allows modeling of buried conductors and underground radial systems.
  - Calculations converge more slowly, requiring significantly more segments (2-4x more) for accurate results, which can increase run time.
  - Permits modeling of elements with varying diameter sections
  - Sources are at the ends of segments (vs. middle)
  - Costs $110 (3-year license)

EZNEC Inputs ~ 40M dipole @ 7.05 MHz & 18'



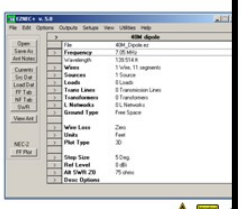
The "usual" equation

→ L = 468 / F

→ 468 / 7.05 MHz.

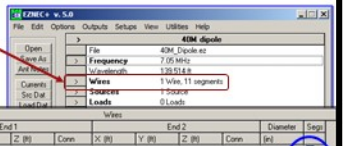
→ ~66.38 ft →

67 ft → 33.5 ft/side



EZNEC Inputs ~ 40M dipole: Wires

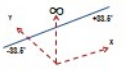
Start by entering the antenna dimensions in Cartesian Coordinates



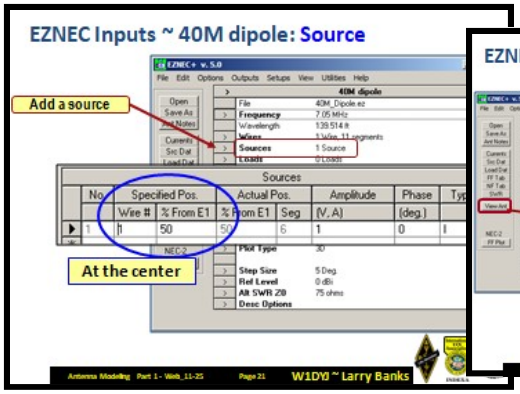
NEC-2

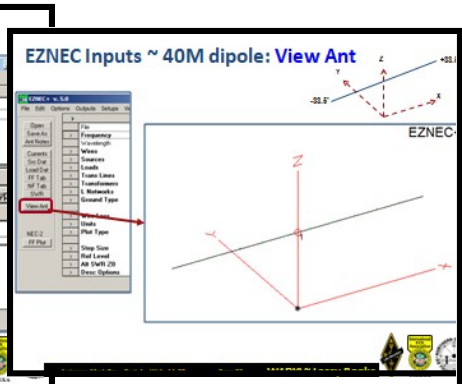
Standard dipole: use 11 segments

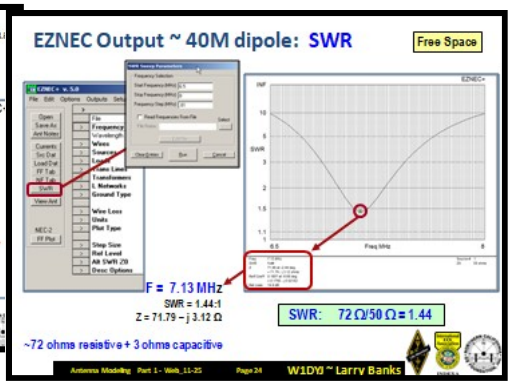
Sources in middle of segment

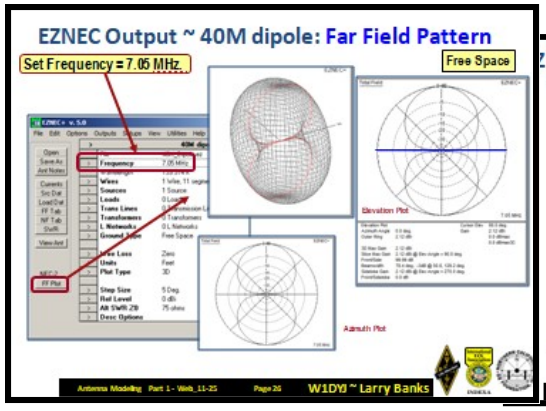


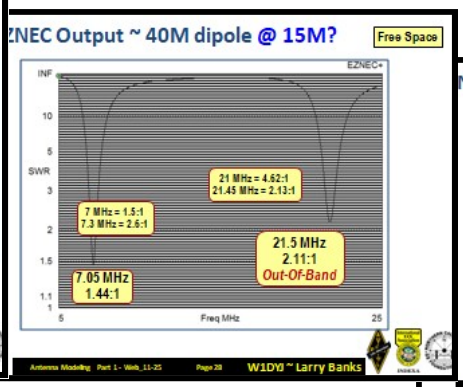
19 November 2025 Membership Meeting ~ Minutes V

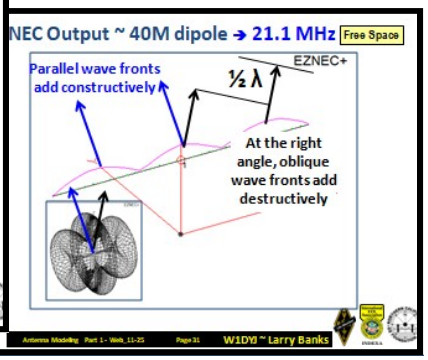


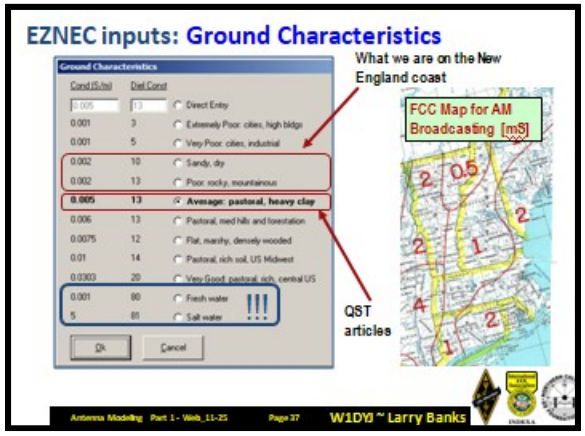


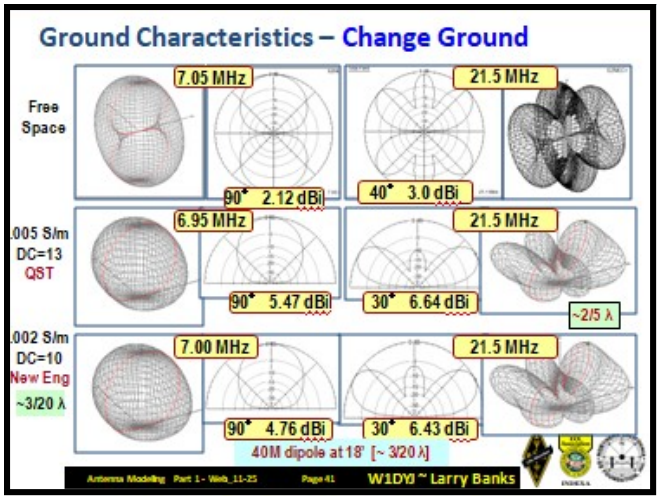

EZNEC Output ~ 40M dipole: SWR
Free Space
F = 7.13 MHz
SWR = 1.44:1
Z = 71.79 – j 3.12 Ω
SWR: 72 Ω/50 Ω = 1.44
~72 ohms resistive + 3 ohms capacitive
W1DYJ ~ Larry Banks

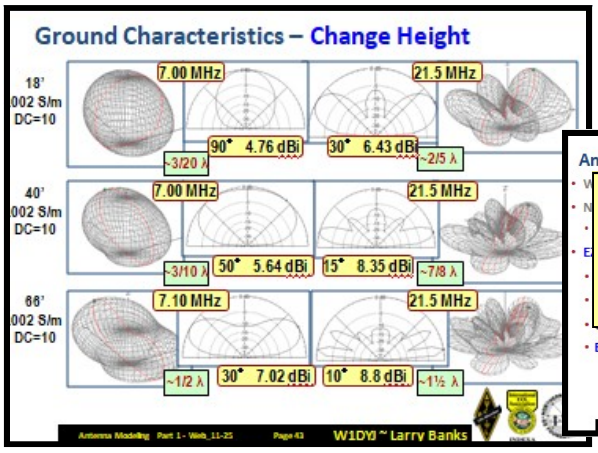


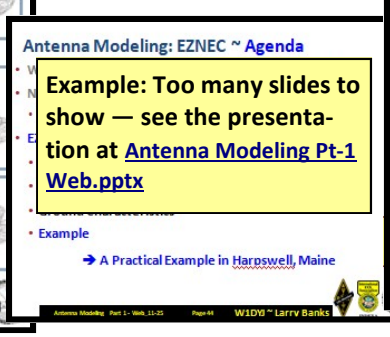


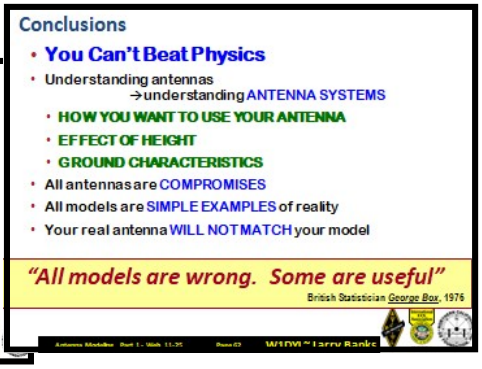

EZNEC Output ~ 40M dipole → 21.1 MHz
Free Space
Parallel wave fronts add constructively
½ λ
At the right angle, oblique wave fronts add destructively
W1DYJ ~ Larry Banks


EZNEC inputs: Ground Characteristics
What we are on the New England coast
FCC Map for AM Broadcasting [mS]
QST articles
W1DYJ ~ Larry Banks






Antenna Modeling: EZNEC ~ Agenda
Example: Too many slides to show — see the presentation at Antenna Modeling Pt-1 Web.pptx
Example
→ A Practical Example in Harpswell, Maine
W1DYJ ~ Larry Banks


Conclusions
You Can't Beat Physics
Understanding antennas
→understanding ANTENNA SYSTEMS
HOW YOU WANT TO USE YOUR ANTENNA
EFFECT OF HEIGHT
GROUND CHARACTERISTICS
All antennas are COMPROMISES
All models are SIMPLE EXAMPLES of reality
Your real antenna WILL NOT MATCH your model
"All models are wrong. Some are useful"
British Statistician George Box, 1976

17 December 2025 Business Meeting ~ Minutes I

Called to order @ 7:34 PM© 2025, MMRA

Repeater Status Report: - Bob DeMattia – K1IW

Billerica 147.12 – PA is intermittent. Probably a well-known failure mode and induced by extreme cold weather. A non-member reported interference on 146.52, which turned out to be a mixing product between 146.82 & 147.12. The mixing point has been determined to be either in that person's radio or on his property. He has not been cooperative, so there is nothing more we can do.

Milton 146.67 & 224.400 – is progressing, antenna climber is onboard, quote received. The 2 m antenna has arrived at the distributor's warehouse. The 222 antenna arrival date has been revised to 1/13/26

Marlborough 927.700 – full configuration is on the air - ASL & IRLP running network.

Boston 927.0625 – full configuration is on the air - ASL & IRLP running network

Hub2 442.700: ASL node is built and ready for deployment before the end of the year. This will completely REPLACE the HUB2 EchoIRLP node with the new ASL node. The Board will decide whether to decommission IRLP node entirely or still support it in another way.

Hub1 449.925: ASL node is built will follow HUB2's deployment when proven successful.

Burlington - 145.43 (ex-Belmont) –pending install of additional cavity to fix de-sense issue.

Weston – 146.79 – Antenna SWR is still high. No activity scheduled to address this yet. The repeater works intermittently. Bob said both Burlington and Weston will be addressed very soon.

All other Repeaters: Functioning normally.

Ham Radio Chat/Elmer Forum – Kevin – K1KWP

These meetings are still on the 2nd Wednesday of each month designed primarily to help new Hams get on the air as well as continue to be informal, relaxed sessions focused on mutual learning. Please go to our website for the Zoom details. Next session is on Wednesday, January 14th at 7:30 PM.

Treasurer's Report– Kevin – K1KWP

A comprehensive breakdown of our expenses was given, itemized line by line. In summary by June 2026 the MMRA is projected to have slightly less than $10,000 in our treasury. This includes the vote we are about to take on the additional expenses for the Billerica and Milton Repeaters.

Vote for Additional Funding: (We had a membership Quorum for this vote).

Billerica unexpectedly required multiple Antenna Climber visits which used up the budget for Milton. Total additional cost to complete Milton is not to exceed $5,000.

Kevin made a motion not to exceed $5,000 to complete the installation of the Repeaters in Milton. It was seconded by Larry and passed unanimously by the membership.

Exam Session – December 2025

Saturday, December 20, 2025, at 9:15 AM

Marlborough Public Library David Meeting Room, 18 Witherbee St, Marlborough MA 01752.

Online Registration is the preferred option. HamStudy.org: Exam details

Walk-Ins are welcome.

Please tell your friends, who are interested in taking tests, that they must have photo IDs and FRNs (and please **obtain your FRN# f**rom the FCC Website **prior to arrival**).

Copy of license required if upgrading (or proof from the ARRL or QRZ)

Note: SS#s, are no longer accepted by the FCC. *Everyone must have an FRN.*

17 December 2025 Business Meeting ~ Minutes II

Exam Session – January 2026

Saturday, January 24, 2026, at 9:00 AM
Marlborough Central Fire Station 215 Maple Street (Rt. 85), Marlborough MA 01752
See above for additional details

Exam Session – February 2026

Saturday, February 14, 2026, at 9:00 AM
1st Lt Charles Whitcomb School, 25 Union St, Marlborough MA 01752
See above for additional details

Upcoming Events:

The Algonquin Amateur Radio Club Flea Market will be held on Saturday, February 14, 2026, at 9:00 AM to 12:00 PM at the 1st Lt Charles W Whitcomb School, 25 Union St, Marlborough, MA.

Admission: $5 general admission
Vendor Tables $25 in advance (before Feb 9), $30 at the door if available
Talk-in Frequency: N1EM/R 446.675 – (pl 88.5)
Amateur License Exam Session: Begins at 9:00 AM

Upcoming Meetings

January 21, 2026, 7:30 PM Membership Meeting NE Sci-Tech and Zoom
Introduction to IT-65 & WSPR *Charles Bures, WA3ITR*
February 18, 2026, 7:30 PM Business Meeting Zoom
March 18, 2026, 7:30 PM Membership Meeting NE Sci-Tech and Zoom
How to Precisely Calibrate Your Transceiver *George Allison, K1IG*
April 15, 2026, 7:30 PM Business Meeting Zoom
May 20, 2026, 7:30 PM Membership Meeting NE Sci-Tech and Zoom
Annual Elections / Emergency Fund Vote
A Technician's Journey: From HT to HF *David Kula, KC1VZH*
Tuesday night at 8:00 PM (year-round) Technical, information and Other Stuff Net
MMRA Linked Repeaters

Newsletter

Please send any newsletter articles or updates to Larry – W1DYJ via email W1DYJ@mmra.org
Due date: Friday January 2, 2026 Publish Date: Monday, January 12, 2026

Zoom Meeting Attendees:

David Hornbaker, N1DCH; Ken Horton, KA1GFN; Larry Banks, W1DYJ; Stephen Babbitt, KC1LPZ; Kevin Paetzold, K1KWP; Roger Coulson, WA1NVC; Bob De Mattia, K1IW; David Kula, KC1VZH; John Mullaney, K1BOS; Tom Sullivan, KC1VHD; Bruce De Graaf, KC1IUS; Kenny Peluso, KC1PFS; Horace Dufresne, KC1TJX; Joe Weisse, W1HAI; Dave Green, K1PRE; Bob Deckert, KC1HCQ; Bruce Bodiya, KC1WIH; Bruce Souza, W1ATO; John Spencer, WA1MDD; Bryan Cerqua, W1BRI;

Meeting Adjourned at 8:24 PM
Respectfully Submitted by Stephen M Babbitt, KC1LPZ, Clerk

Free Amateur Extra Class Starts January 15

If you or someone you know wants to upgrade to Extra then I highly recommend classes with these people. This is a class where people will learn all the stuff for general and why the questions are on the test. Not just how to pass the test.

This is actually the class that I took in order to finally upgrade to Extra after previous incomplete attempts.

I will be happy to answer any questions you might have about the course: *K1KWP@mmra.org*

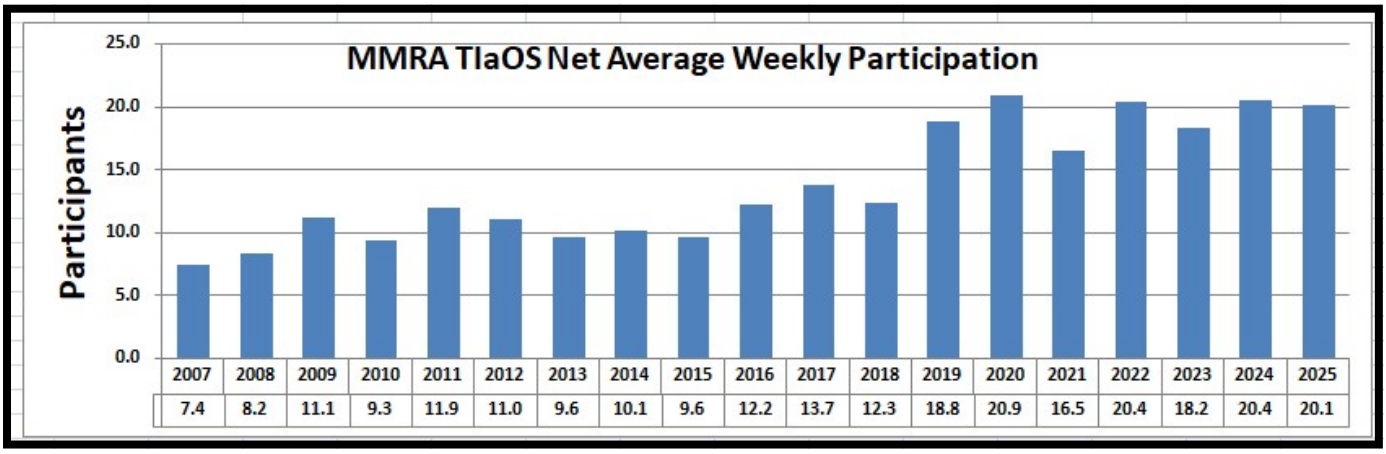
73 — K1KWP

A free, weekly, live, Amateur Radio Extra Class Licensing course on Zoom will begin on Thursday, January 15, 2026, and will run through Thursday, March 26. There will be 11 sessions. The three-hour sessions will start at 6:30 PM Eastern Time and will also be recorded. These are the classes that we have been holding for years sponsored by the Amateur Radio Club of the National Electronics Museum. Note: Attendees should hold (or be studying for) the General Class Amateur Radio License.

Those wishing to sign up should email: **roland.anders@comcast.net**

73 — Rol Anders, K3RA

TIaOS Net — Annual Report ~ Larry Banks, W1DYJ



In 2025 weekly participation was around 20. The largest participation during 2025 was on 7 January with 29 check-ins. I want to thank Jonathan, K1BTZ ; Kevin, K1KWP; Dave, KC1VZH; and Tom, KB1OQA for being net controls during this past year. We all hope to hear you Tuesday nights at 8 pm.

And we would be HAPPY to have you (any of you…) volunteer to be a Back-Up NC!!! We have a script you can use. All of our current NCs would welcome you to the "club."

Upcoming MMRA Meetings

Meetings usually start at 7:30 PM
Meeting locations and times are subject to change.
Consult the MMRA website for the most up-to-date information.

ZOOM Teleconference login info is available once you log into your account on MMRA.ORG

Non-members: if you wish to attend, email contact@mmra.org.

Elmer Forums / ZOOM: 1/14, 2/11, 3/11, 4/8, 5/13

Business Meetings / ZOOM: 2/18, 4/15

Membership Meetings

January 21, 2026 Location: NE Sci-Tech + Zoom
Speaker: Charles Bures - WA3ITR
Introduction to IT-65 & WSPR

March 18, 2026 Location: NE Sci-Tech + Zoom
Speaker: George Allison - K1IG
How to Precisely Calibrate Your Transceiver

May 20, 2026 Location: NE Sci-Tech + Zoom
Annual Meeting & Elections
Speaker: David Kula -KC1VZH
A Technician's Journey: From HT to HF

Join Us! Every Tuesday @ 8 PM

Technical, Informational and Other Stuff Net

Keep up with what's happening in the MMRA and ask your ham related questions.

Net Control Operators:

Week 1	W1DYJ	Larry Banks
Week 2	K1BTZ	Jonathan Traum
Week 3	K1KWP	Kevin Paetzold
Week 4	KC1VZH	David Kula
Week 5	KB1OQA	Tom Turner

To connect using Echolink: Conference *NEW-ENG2*

NOTE: we need another NC to be available as a substitute. If you are interested, email: W1DYJ@mmra.org

MMRA Leaders

Executive Board — Officers

President	Dave Hornbaker	N1DCH
Vice President	John Spencer	WA1MDD
Secretary	Ken Horton,	KA1GFN
Treasurer	Kevin Paetzold	K1KWP
Clerk	Stephen Babbitt	KC1LPZ

Executive Board — Directors

Director >2026	Rob Evans	N1BE
Director >2026	James Lee	N1DDK
Director >2027	Bob DeMattia	K1IW
Director >2027	Roger Coulson	WA1NVC

Appointed, Voting

Technical Officer	Bob DeMattia	K1IW

Repeater Trustees

Billerica 147.12, 224.88	Mike Rioux	W1USN
Boston 146.82	John Mullaney	K1BOS
Boston 927.0625	Rick Zach	KK1RZ
Brookline 145.16	Joyce DeMattia	K1MRA
Burlington 145.43	Ed Curley	KC1CLA
Hopkinton 447.775	Bryan Cerqua	W1BRI
Lowell 442.25	Bob Phinney	K5TEC
Marlborough 53.81	Bryan Cerqua	W1BRI
Marlborough: 29.68, 144.39, 147.27, 223.94, 224.70 449.575, 449.925, 927.70 all as W1MRA	Bill Northup	N1QPR
Mendon 146.61	Kevin Paetzold	K1KWP
N. Reading 146.715	Bruce Pigott	KC1US
N. Reading 446.775	Larry Banks	W1DYJ
Milton 224.40	Bill Dunn	N1KUG
Milton 146.67	Bryan Cerqua	W1BRI
Weston 146.79	Joe Weisse	W1HAI
Weston 224.70	Bill Northup	W1MRA
Weston 442.70	Dave Hornbaker	N1DCH

Additional, non-Voting

Newsletter Editor	Larry Banks	W1DYJ
Emerg. Coord.	Kevin Paetzold	K1KWP
Pub. Serv. Coord.	Bruce Pigott	KC1US
VEC Liaison	Ron Rothman	WO1E
Net Manager	Larry Banks	W1DYJ
Web Page Editor	Bob DeMattia	K1IW

President Emeritus

Bob DeMattia K1IW

Technical Officer Emeritus

Bryan Cerqua W1BRI

About the Minuteman Repeater Association

MMRA Control Operators Responsibilities

https://www.mmra.org/MMRACOPolicy-March2019.pdf

The Minuteman Repeater Association (MMRA) is dedicated to Amateur Radio and public service. The MMRA maintains a large system of repeaters in Eastern Massachusetts.

The MMRA meets each month from September to June. Meeting times, locations, and talk-in frequency vary and are announced in this newsletter and on weekly nets. Meetings are open to all interested parties. Guest speakers and programs of general interest occur in September, November, January, March, and May. The intervening meetings are also open to all members and are for general business.

The Minuteman newsletter is emailed one week before each general interest meeting. Members are encouraged to submit articles: send to the editor at newsletter@mmra.org. The deadline for articles is the last Friday of the month preceding the meeting.

Each Tuesday evening at 8pm the MMRA links most of the repeaters for an open net. The topic is "Technical Information and Other Stuff". Join us!

Membership in the MMRA is open to all radio amateurs. Annual dues are $25 per individual or $35 per family. See our website for details.

Contact information is listed on the top of the last page of this newsletter.

MMRA QRM Policy

MMRA members and all other operators are strongly encouraged to report repeater activity that does not abide by Part 97 rules or accepted amateur radio practice to the board of directors at contact@mmra.org or via other means.

The most effective way (and probably the only effective way) to deal with an individual causing QRM is to NOT engage with that individual on the air. Please include the time and date of any incident.

Repeater and Frequency Information

Band	XMTR Location	Freq	PL	Call	Linking To: Hub 1	Hub 2
10m	Marlboro East	29.680	131.8	W1MRA	???	???
				Linked to 146.79: 9am-3pm every day		
6m	Marlboro East *Remote receive Marlboro West: PL=100*	53.810	71.9	W1BRI	PTL	PTL
2m	Brookline	145.160	na	K1MRA	D-Star (REF050C)	
	Burlington	145.430	146.2	KC1CLA	FTL	PTL
	Mendon	146.610		K1KWP	FTL	PTL
	Milton	146.670		W1BRI	FTL	PTL
	North Reading	146.715		KC1US	FTL	PTL
	Weston	146.790		W1HAI	PTL	PTL
				Linked to 29.68: 9am-3pm every day		
	Boston	146.820		K1BOS	FTL	PTL
	Billerica *Output tone = 162.2*	147.120		W1DC	PTL	PTL
	Marlborough	147.270		W1MRA	PTL	PTL
1.25m	Marlborough	223.940	103.5	W1MRA	FTL	PTL
	Milton	224.400		N1KUG	FTL	PTL
	Weston	224.700		W1MRA	PTL	PTL
	Billerica	224.880		W1DC	FTL	PTL
70cm	Lowell	442.250	88.5	K5TEC	FTL	PTL: 446.775
	Weston *	442.700	88.5	N1DCH	Network Hub 2 (PTL to Hub 1)	
	North Reading *System Fusion*	446.775	88.5 71.9 Local Link	W1DYJ	FTL [88.5]	PTL [88.5]
	Hopkinton *System Fusion*	447.775	88.5 71.9 Local Link	W1BRI	FTL [88.5]	PTL [88.5]
	Marlborough	449.575	na	W1MRA	D-Star (REF050C)	
	Marlborough *	449.925	88.5	W1MRA	Network Hub 1	
33cm	Boston *	927.0625	D244	KK1RZ	PTL	PTL
	Marlborough * *PL out = 131.8*	927.700		W1MRA	PTL	PTL
Marlborough		144.390	none	W1MRA	APRS Digipeater	
???		145.630	146.2	W1MRA	Fox Box	

*Internet

HUB1– 449.925: IRLP 4133 / Echolink 4133
Connected to Echolink NEWENG2 conference (9127) for TIAOS net.

HUB2 – 442.700: Allstar 671072 / Echolink 4136

927.0625: Allstar 65011 IRLP 4977
927.700: Allstar 65010 IRLP 4978

Normally linked to the NE900 Reflector, 9125. Linked to MMRA via "NEW-ENG2" node 9127 for the TIAOS net. Normally linked together.

Notes: FTL = Full Time Linked (or default state)
PTL = Part Time Linked (on schedule or demand)
A repeater can be linked to only one Hub at a time, however the two hubs can also be linked together.

Contacting the MMRA

Members: join mmra@groups.io
to receive member emails.
You must be approved by the moderator.
Officers: contact@mmra.org
Control Ops: control-ops@mmra.org

Minuteman Repeater Association
PO Box 2192
Littleton, MA 01460-3192

http://www.mmra.org/

https://www.facebook.com/mmraham

MMRA Amateur Radio Exam Sessions

Check out https://www.mmra.org/exam.html or email *ve@mmra.org*

Ask your friends to become a member **Just let them know that it is not fully automated. Although they can log into the MMRA website immediately, they need to be manually processed. This could take up to a week.**

If you haven't updated your MMRA profile in a while, now is the time! Log into < MMRA.ORG > to do so.

Previous issues of the MMRA Newsletter are available at: MMRA Newsletter Archive.
They are also available at DLARC: https://archive.org/details/minuteman-repeater-association

Note: Newsletter licensed under CC-BY-4.0: *https://creativecommons.org/licenses/by/4.0/*

Nets, etc., on the MMRA System

MMRA Technical Information and Other Stuff Net
Our weekly club net on most of the MMRA repeaters, Tuesday night at 8:00 pm local.

Heavy Hitters Traffic Net
This ARRL NTS net is active on our repeaters Sunday to Friday evenings from 9:45—11pm and Saturday from 10-11pm.

Coast Guard Net Sundays at 11:00am local.

ARES Net First Monday at 8:30pm local.

STARS Net Second Tuesday 7:00—7:45pm local.

ARRL Audio News Sundays at 7pm local

< https://www.mmra.org/repeaters/repeater_linking.html >

NEW ENGLAND SCI-TECH

New England Sci-Tech Inc is a new 501(c)(3) STEM education center, amateur radio training center, and maker space located at 16 Tech Circle, Natick. It is home to New England Amateur Radio Inc (NE1AR) and the youth radio club Sci-Tech Amateur Radio Society (STARS). NE Sci-Tech welcomes memberships and donations via www.NESciTech.org or www.NE1AR.org.

Get connected on the MMRA Repeater System ~ Dave Hornbaker N1DCH

What is the best way to get connected on the MMRA repeater system? Try announcing yourself! Just say your call sign followed by "listening". If you want, you can include the last 3 digits of the repeater frequency. For example, "N1DCH listening" or maybe "N1DCH listening on 925", you may very well get a response. Try to connect by announcing yourself several times.

Most of the time, Marlborough Hub1 (449.925) is linked to the following repeaters, Boston (146.820), North Reading (446.775 *and* 146.715), Mendon (146.610), Lowell (442.250), and Hopkinton (447.775.) Remember that when the repeaters are linked, you need to wait two or three seconds after you key up and before you speak. This is especially important on the TIaOS net on Tuesday when most of the repeaters are linked.

You can also link (and delink) the repeaters yourself. See the information you received when you became a member, or check the User Control Codes once you log into the MMRA website.

Try one of the non-linked repeaters too. There are Hams monitoring them as well. For more information on the repeater network and how it is linked at various times, check out https://mmra.org/repeaters/repeater_linking.html.